certainly not the case. Usually there is no silent area. Again, although according to the analogy of Lloyd's bands there might be a dark or silent place at a particular height above the water, say on the bridge of the *Irene*, the effect should be limited to the neighbourhood of the particular height. At a height above the water twice as great, or near the water level itself, the sound should be heard again. In the latter case there were some difficulties, arising from disturbing noises, in making a satisfactory trial; but as a matter of fact, neither by an observer up the mast nor by one near the water level was a sound lost on the bridge ever recovered.

The interference bands of Fresnel's experiment may be imitated by a bifurcation of the sound issuing from A (Fig. 1). For this purpose a sort of T-tube is fitted, the free ends being provided with small elliptical cones, similar to that already described, the axes of which are parallel and distant from one another by about 40 cm. The whole is constructed with regard to symmetry, so that sounds of equal intensity and of the same phase issue from the two cones the long diameters of which are vertical. If the distances of the burner from the mouths of the cones be precisely equal, the sounds arrive in the same phase and the flame flares vigorously. If, as by the hand held between, one of the sounds is cut off, the flaring is reduced, showing that with this adjustment the two sounds are more powerful than one. By an almost imperceptible slewing round of the apparatus on its baseboard, the adjustment above spoken of is upset and the flame is induced to recover its tall equilibrium condition. The sounds now reach the flame in opposition of phase and practically neutralise one another. That this is so is proved in a moment. If the hand be introduced between either orifice and the flame, flaring ensues, the sound not intercepted being free to produce its proper effect.

The analogy with Fresnel's bands would be most complete if we kept the sources of sound at rest and caused the burner to move transversely so as to occupy in succession places of maximum and minimum effect. It is more convenient with our apparatus and comes to the same thing, if we keep the burner fixed and move the sources transversely, sliding the base-board without rotation. In this way we may verify the formula, connecting the width of a band with the wave-length and the other geometrical data of the experiment.

The phase discrepancy necessary for interference may be introduced, without disturbing the equality of distances, by inserting in the path of one of the sounds a layer of gas having different acoustical properties from air. In the lecture carbonic acid was employed. This gas is about half as heavy again as air, so that the velocity of sound is less in the proportion of $1:1\cdot25$. If l be the thickness of the layer, the *retardation* is $\cdot25\,l$; and if this be equal to the half wave-length, the interposition of the layer causes a transition from complete agreement to complete opposition of phase. Two cells of tin plate were employed, fitted with tubes above and below, and closed with films of collodion. The films most convenient for this purpose are those formed upon water by the evaporation of a few drops of a solution of celluloid in pear-oil. These cells were placed one in the path of each sound, and the distances of the cones adjusted to maximum flaring. The insertion of carbonic acid into *one* cell quieted the flame, which flared again when the second cell was charged so as to restore symmetry. Similar effects were produced as the gas was allowed to run out at the lower tubes, so as to be replaced by air entering above.[1]

Many vibrating bodies give rise to sounds which are powerful in some directions but fail in others—a phenomenon that may be regarded as due to interference. The case of tuning forks (unmounted) is well known. In the lecture a small and thick wine-glass was vibrated, after the manner of a bell, with the aid of a violin bow. When any one of the four vibrating segments was presented to the flame, flaring ensued; but the response failed when the glass was so held at the same distance that its *axis* pointed to the flame. In this position the effects of adjacent segments neutralise one another and the aggregate is zero. Another example, which, strangely enough, does not appear to have been noticed, is afforded by the familiar open organ pipe. The vibrations issuing from the two ends are in the same phase as they start, so that if the two ends are equally distant from the percipient, the effects conspire. If, however, the pipe be pointed towards the percipient, there is a great falling off, inasmuch as the length of the pipe approximates to the half wave-length of the sound. The experiment may be made in the lecture-room with the sensitive flame and one of the highest pipes of an organ, but it succeeds better and is more striking when carried out in the open air with a pipe of lower pitch, simply listened to with the unaided ear of the observer. Within doors reflections complicate all experiments of this kind.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 235th meeting of the Junior Scientific Club was held on May 2 in the physiological lecture room at the Museum. Two papers were read, "A New Type of Vertebrate Kidney," by Mr. E. S. Goodrich, Merton College, and "The Prussic Acid Problem," by Mr. J. M. Wadmore, Trinity College.

The ninth Robert Boyle lecture of the Junior Scientific Club will be delivered by Prof. T. Clifford Allbutt, F.R.S., in Balliol College Hall on Tuesday next, May 13. The subject will be "The Growth of the Experimental Method in Oxford."

THE honorary degree of LL.D. was conferred on Lord Kelvin on Monday by the University of Yale.

A MEETING will be held at the Mansion House to-morrow, May 9, at 3 p.m., with the Lord Mayor in the chair, in support of higher university education and research in London, with special reference to the fund being raised for the endowment of University College and its incorporation in the University of London. All who are interested in national progress and the advancement of knowledge are invited to take part in this movement for making up in some degree the gaps in our educational system, and in the endeavour to place at the disposal of the inhabitants of London facilities for mental training at any rate equal to those enjoyed by our continental neighbours. Among the speakers at the Mansion House meeting will be the Duke of Devonshire, Lord Brassey (chairman of the Appeal Committee), Lord Avebury, Mr. Ritchie, M.P., the Hon. Alban Gibbs, M.P., Sir Michael Foster, M.P., Principal Rücker, F.R.S., Mr. Lionel Phillips, and Mr. H. R. Beeton.

THE debate on the second reading of the Education Bill of the Government was opened in the House of Commons on Monday. Mr. Bryce gave reasons for believing that the Bill would not establish satisfactory local authorities, secure educational improvement, or effect a final settlement of the education question. Referring to secondary education, Mr. Bryce said that the Bill promises to do nothing for it, though secondary education is the most urgent of all our educational wants. "It does not direct any inquiry or any scheme to be made for the reorganisation of secondary education. It does not impose any duty upon the new authorities to provide secondary education, however great the local need may be. It is purely permissive. It does not contain any suggestion for dealing with endowments or for the reorganisation of schools. It does not set apart the grant under the Act of 1890 as only applicable to secondary education. It gives a rating power up to 2*d*., with the possibility of increase by the consent of the Local Government Board. Secondary education ought to have had a Bill to itself, and it ought to have had a start of two or three years before primary education is thrown upon the same authority, if ever it is to be thrown upon it. Now, the probability is that secondary education will go to the wall." Sir John Gorst urged in reply that the Bill creates an authority, or it gives to the authority already existing for technical education full powers for secondary education, and so may be said to do something for secondary education. As to the inadequacy of the funds available under the Bill, it was held that the County Councils had enough to begin with, "and," added Sir John Gorst, "if this Bill is passed it will, at all events, make a beginning of secondary education, and when the authorities of counties and county boroughs see what sum of money is really required, I have no doubt the representations made by them to this House will be received with very fair consideration." The debate was continued on Tuesday, and among the points discussed were the comparative merits of School Boards and County Councils as local authorities for education, need for better training of teachers, the extension of the limit of a 2*d*. rate, and the need for generous grants from the Exchequer for secondary education.

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[1] In a still atmosphere the hot gases arising from lighted candles may be substituted for the layers of CO_2.

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THERE will be an exhibition of scientific apparatus at the conference of science teachers to be held at Festiniog on May 15 (see p. 599, April 24). Good apparatus is urgently required in many Welsh schools, and manufacturers ought to hasten to avail themselves of the opportunity which the conference affords of exhibiting instruments and materials essential to practical instruction in science. Mr. J. Griffith, County School, Festiniog, has entire charge of the exhibition arrangements, and would provide rooms and allocate space for the display of scientific apparatus.

THE Technical Education Board of the London County Council will shortly award five senior county scholarships. The scholarships are open to young men and young women who are resident within the administrative county of London whose parents are in receipt of an income not exceeding 400*l.* a year. They are tenable for three years at British or foreign Universities and technical colleges of University rank, and are of the value of 90*l.* a year. Candidates should as a rule be not more than twenty-two years of age, preference being given to those who are under nineteen years of age. In addition to the scholarships, the Board offers for competition a limited number of free places at the principal London colleges. Application forms can be obtained from the secretary of the Technical Education Board, and must be returned not later than Monday next, May 12.

A MEETING of the Association of Technical Institutions will be held between the second reading of the Government Education Bill and the Committee stage. At this meeting the council will recommend the Association to adopt the following resolutions in regard to the Bill:—(1) That this Association cordially approves the general principles upon which the Government Education Bill is based, and strongly urges His Majesty's Government to pass the Bill in the present session of Parliament. (2) That this Association is strongly of opinion that the new local authorities should be responsible for all grades of education in their districts, and that proper educational coordination would be seriously and unnecessarily hindered if this principle were not adopted; it therefore urges the Government to amend the Bill by deleting the clauses making it optional for the County and Borough Councils to undertake the supervision of elementary education. (3) That this Association regrets to note that the Bill makes optional the application to the purposes of higher education of the residue under the Local Taxation (Customs and Excise) Act, 1890, and it requests the Government to make such application compulsory. (4) That this Association regrets the exclusion of London from the Bill and trusts that the metropolis may receive attention early next year, and, while recognising that the case of London requires special treatment, is of opinion that it would be unwise to depart from the general principles of the present Bill in the case of London.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1901.—"On the Action of the Spurge (*Euphorbia hiberna*, L.) on Salmonoid Fishes." By H. M. Kyle, M.A., D.Sc., St. Andrews University. Communicased by Prof. McIntosh, F.R.S.

It has been known for some years that the Irish peasantry employed a simple method of procuring salmon and trout through the agency of the Spurge (*E. hiberna*, L.). The plant cut into small pieces and pounded with stones, or simply trampled upon at some convenient spot on a river, forms an emulsion in the water which, being swept downward into the pools, carries death to all fishes in its course. The fatality thus produced seems to have been enormous—80 to 100 salmon are reported to have been killed at one time, and again in the Bandon rivers 500 to 1000 fish of various descriptions are said to have been poisoned during one season. In the light of the experiments to be recorded presently, these statements do not seem exaggerated, for the Spurge-extract, even in small quantities, is almost as fatal to fishes as corrosive sublimate.

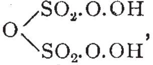
The fatal effect of the Spurge on fishes has been known in other countries besides Ireland, but to what ingredient or ingredients of the plant these effects are due seems never to have been investigated. The experiments described in the present paper throw considerable light upon the action of the Spurge, and open out to view some interesting problems.

Chemical analysis of the Spurge-extract shows that it contains tannic acid. Experiments on the circulation in the lung and mesentery of the frog reveal a close similarity between the action of the Spurge-extract and of tannic acid. In the case of trout the similarity extends to the non-recovery of the fish in fresh water, after they have come under the influence of either Spurge-extract or tannic acid. The power of the Spurge-extract to produce fatal effects persists for several days without diminution. Twenty per cent. of the fresh extract is fatal within five minutes, whilst 0·01 per cent. takes 4 to 6 hours, and seems to be the smallest percentage which has fatal results. In the case of fishes, death is considered to ensue from the inflammation of the gills and consequent stasis of the circulation, set up by the action of the tannic-acid component of the Spurge-extract. The fresh extract is calculated roughly to contain about 1 per cent. of tannic acid, but on this estimation the Spurge-extract is fatal within a shorter period than the corresponding quantity of tannic acid. Hence, the percentage of tannic acid has been under-estimated, or some other substance or substances in the extract also aid in producing fatal effects.

March 20.—"Persulphuric Acids." By Prof. Henry E. Armstrong, V.P.R.S., and T. Martin Lowry, D.Sc.

The "remarkable disappearance of oxygen" which Faraday, in 1834, observed to take place on electrolysing strong solutions of sulphuric acid was shown by Berthelot, in 1878, to be due mainly to peroxidation of the sulphuric acid. An anhydride, S_2O_7, was isolated, and he therefore concluded that the corresponding per*di*sulphuric acid, $H_2S_2O_8$, was formed when sulphuric acid was peroxidised either by anode oxidation or by interaction with hydrogen peroxide. The per*di*sulphates were isolated by Marshall, in 1891, by electrolysing solutions of acid sulphates, and have found a technical application in photography. This simple explanation of the peroxidation of sulphuric acid remained unchallenged until Caro found, in 1898, that when the per*di*sulphates are dissolved in sulphuric acid and the solution is again neutralised, a product is obtained which possesses the property of oxidising aniline to nitrosobenzene. None of the salts of Caro's modified persulphuric acid have yet been isolated, and only indirect methods are therefore available for determining its constitution.

Von Baeyer and Villiger have determined the ratio of sulphur to active oxygen in a solution containing the barium salt of Caro's acid, and found the ratio to be $SO_3 : O = 1 : 1$, the ratio for Marshall's salts being $SO_3 : O = 2 : 1$. They therefore assigned to Caro's acid the formula H_2SO_5 of a per*mono*sulphuric acid. If this acid be dibasic its salts must remain neutral when reduced, thus $CaSO_5 = CaSO_4 + O$, whereas any higher member of the series would liberate acid, thus $CaS_2O_8 + H_2O = CaSO_4 + H_2SO_4 + O$. Caro's salts are extremely unstable in presence of caustic alkalis, but neutral solutions can be prepared by neutralising with carbonates; when such solutions are heated they lose their active oxygen and liberate acid in the ratio $H_2SO_4 : O_2$. This result can only be reconciled with the formula of von Baeyer and Villiger by assuming per*mono*sulphuric acid to be monobasic, $NaHSO_5 = NaHSO_4 + O$; a more probable view is that Caro's acid is the *anhydro*-acid,



$$O\begin{cases}SO_2.O.OH\\SO_2.O.OH\end{cases}$$

, and that its salts are comparable with the *pyro*sulphates and the *di*chromates, $CaS_2O_9 + H_2O = CaSO_4 + H_2SO_4 + O_2$.

In concentrated solutions containing less than 50 per cent. of water, the peroxidation of sulphuric acid proceeds differently, the chief product being probably a per*tetra*sulphuric acid, $H_2S_4O_{14}$ (Lowry and West, Chem. Soc. *Trans.*, 1900, 950). This acid, the fourth member of the series $H_2O_2.nSO_3$, bears to pyrosulphuric acid the same relationship as that which per*di*sulphuric acid bears to sulphuric acid, $2H_2S_2O_7 - H_2 = H_2S_4O_{14}$, $2H_2SO_4 - H_2 = H_2S_2O_8$. On dilution and neutralisation it is hydrolysed to a salt of Caro's acid.

At the present time it is therefore necessary to postulate the existence of at least three persulphuric acids, in which the ratio $SO_3 : O$ is 1:1, 1 : 2 and 1 : 4 respectively. In spite of the stability of the perdisulphates, the least stable of these is per*di*sulphuric acid, for when liberated from its salts it rapidly passes in dilute solution to a per*mono*sulphuric acid (Caro's acid), whilst in presence of concentrated sulphuric acid it is converted mainly into per*tetra*sulphuric acid.

"On a Throw-testing Machine for Reversals of Mean Stress." By Osborne Reynolds, F.R.S., and J. H. Smith, M.Sc.

This research was undertaken at the suggestion of Prof.

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